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ABSTRACT

This document presents an overview of the current status of cost-effectiveness analysis and related techniques as they should be and are being applied to the field of educational technology, including an annotated bibliography of cost-effectiveness. Intended for practitioners with a basic understanding of instructional technology, this report is designed to guide improvement in the design, conduct, and use of cost-effectiveness studies in this area. Initial narrative sections examine the concepts and practice of cost-effectiveness evaluation and/or analysis as applied to instructional technology, and provide an overview of the literature on this topic. Citations are included throughout this portion of the document so that more informed selections of follow-up literature can be made. An appendix provides a review of the development of the practice of cost-effectiveness analysis of instructional technology programs and a brief review of that literature. Citations in this section are included in the list of references. (Author)

COST-EFFECTIVENESS ANALYSIS

AND

INSTRUCTIONAL TECHNOLOGY:

A Review of Conceptual Issues

and Selected References

by

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OVERVIEW

In 1968, the fledgling ERIC system indexed twenty-two references in Resources in Education (RIE) under the specific descriptor "cost-effectiveness". Now, more than ten years later, the annual average is nearing one hundred. In addition, nearly one hundred journal articles are indexed each year in Current Index to Journals in Education (CIJE) using the term cost-effectiveness. Reported applications of economic analysis procedures to instructional technology have shown a similar growth but on a more limited scale. What is there to be gleaned by educational technologists from such documents and articles on functional cost analysis, cost-effectiveness analysis, economic analysis, and program cost evaluation?

In answer to this question, this ERIC Information Analysis Product is intended to present an overview of the current status of cost-effectiveness analysis and related techniques as they should be and are being applied to the field of instructional technology. A selected and categorized annotated bibliography has been created to guide further study. In addition, the references section has been expanded to assist individuals seeking reports of applications in specific contexts as well as reviews of concepts and techniques.

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INTRODUCTION

Current conditions facing this country's educational systems make it imperative that we examine the cost-effectiveness of its instructional acitivities and consider new ways of handling those activities. The educational system is in a dilemma: On the one hand it is experiencing a financial crisis, and on the other it is subject to increasing public criticism of both the cost and the quality of its outcomes. To resolve this situation, educators must find new ways to maintain or improve the quality of their services while more carefully controlling their costs.

Instructional technology provides alternative approaches to the conduct of educational activities and cost-effectiveness analysis provides one means of evaluating the relative worth of those approaches in achieving desired educational outcomes. Applications of instructional technology which are judged as having an appropriate relationship of costs to effectiveness can be adopted by educators to help them maintain a proper balance between the cost and quality of their services. For this plan to work, however, instructional technologies must exist which represent at least potential improvements over conventional approaches and the methods of cost-effectiveness analysis must be good enough to determine the nature of those improvements.

Intended for practitioners with a basic understanding of instructional technology, this Information Analysis Product is designed to guide improvement in the design, conduct, and use of cost-effectiveness studies in this area. Initial narrative sections examine the concepts and practice of cost-effectiveness evaluation and/or analysis as applied to instructional

technology, and provide an overview of the literature on this topic. Citations are included throughout this portion of the document so that more informed selections of follow-up literature can be made.

For the user desirous of additional background information, the appendix provides a review of the development of the practice of cost-effectiveness analysis of instructional technology programs and a brief review of that literature. Citations in this section are included in the list of references.

COST EFFECTIVENESS ANALYSIS

Nature of Cost-Effectiveness Analysis

Cost-effectiveness analysis is one of a family of analysis activities known generally as systems analysis. Systems analysis is loosely related to the theory of general systems developed in the 1930's by Bertalanffy (1968). It is based more directly upon work in the wartime field of operational analysis (Beilby, 1977a, p. 10; Quade, 1971, p. 10). In current usage, the concept of systems analysis encompasses several specific kinds of analysis activity, including cost-benefit analysis and cost-utility analysis in addition to cost-effectiveness analysis.

The basic nature of systems analysis has been characterized as "an effort to apply structured rationality to problems of choice" (Dror, 1969, p. 6). Dror's reference to the "structured rationality" of the approach is illustrated in the following definition of systems analysis:

> Systems analysis may be defined as inquiry to assist decision-makers in choosing preferred future courses of action by (1) systematically examining and reexamining the relevant objectives and the alternative policies for achieving them; and (2) comparing quantitatively where possible the economic costs, effectiveness (benefits), and risk of the alternatives. (Fisher, 1971 p. 6)

The "problems of choice" Dror referred to provide the basis for distinguishing among the various forms of analysis. Specifically, cost-effectiveness analysis is designed to assist a decision-maker faced with the problem of choosing among alternative approaches to a particular goal. The relative desirability of the approaches is determined through a comparison of resource requirements and outcomes of the different alternatives. Cost-benefit analysis is also concerned with the comparison

of the resource requirements and outcomes of alternatives, but this time the problem is that of choosing among different goals as well as among the means of achieving each. Finally, when the problem of choosing between alternatives involves more than the determination of relative effectiveness and efficiency, and becomes concerned with issues relating to equity, social impact and the decision-maker's values, the most appropriate technique is cost-utility analysis (Tuscher, 1974).

These distinctions between the various types of analysis, however, are not usually this clear. All forms of analysis draw heavily upon a common set of theories and techniques from such areas as economics, engineering, and decision theory (Grosse, 1967, p. v; Quade, 1975, p. 22). The simplest way to understand any of these analysis types is to review the main characteristics they all have in common.

Characteristics of Analysis Activities

Various authors (particularly Doughty, 1973; Fisher, 1971; Quade, 1965b, 1975) have identified a number of characteristics of analysis activities that are common to all forms of analysis. In a sense these characteristics are the building blocks of the methods for cost-effectiveness and other analysis efforts. Combining the observations of these and other authors results in seven distinct characteristics of analysis activities: phase, purpose, function, level, variables, elements, and subsystems. Each is described below.

Phases of analysis activities. Quade and Boucher (1968) and Fisher (1971) have defined the basic process of analysis as proceeding through a series of iterations over five phases.

Formulation (The Conceptual Phase)	Clarifying the objectives, defining the issues of concern, limiting the problem, searching out good criteria for choice.
Search - Including the Development of Hypotheses (The Research Phase)	Looking for data and relationships, as well as alternative programs of action that have some chance of solving the problem.
Evaluation (The Analytic Phase)	Building various models, using them to predict the consequences that are likely to follow from each choice of alternatives, and then comparing the alternative in terms of these consequences.
Interpretation (The Judgmental Phase)	Using the predictions obtained from the models and whatever other information or insight is relevant to compare the alternatives further, derive conclusions about them, and indicate a course of action.
Verification (The Testing Phase)	Testing the conclusions wherever possible (Fisher, 1971, pp. 8-9).

Of these five phases, Fisher notes that it is probably the formulation phase that is most critical to the success of the analysis. It is in the handling of this first phase that the characteristics of purpose, function and level are of primary concern.

Purpose. Analysis activities can be designed to serve three general purposes. As identified by Doughty (1973, pp. 16-18) the purposes are descriptive, predictive, and comparative. A descriptive analysis is conducted to describe the costs and outcomes of an ongoing program. Results from descriptive analyses coupled with other kinds of information (particularly that gained from modeling) can be used to conduct predictive analyses of the potential costs and outcomes of proposed programs. Finally, comparative analyses compare programs (alternatives) by employing either descriptive analysis for "ex post facto" comparisons or predictive analysis for a priori comparisons. Beyond these three characteristics purposes, there are a number of specific purposes which different types

of analysis are more or less suited to address. These specific purposes include "the allocation of resources among identified objectives... the choice of alternative means to meet the given objectives... the assessment of the worth of different objectives... (and) the systematic generation of alternatives which were not originally identified" (Doughty, 1973, p. 18).

Function. Analysis efforts are designed to aid decision-making. In particular, there are four important functions of decision-making which analyses can serve. These functions have different purposes and outcomes but are closely interrelated (Doughty, 1973, p. 15). First, analysis may serve a control function when the decision-maker is concerned with managing and monitoring the flow of resources and level of output. Analysis activities may also support the function of planning for predicted changes in the resources and outcomes of activities. A third function is that of evaluation where the emphasis is on comparing the desired versus the actual costs and outcomes of an activity. Finally, analyses may be conducted to serve a development function in order to assist in the generation, design, and implementation of new activities.

Level. Another major characteristic of analysis activities is that they should differ according to the level of decisions and information needs being served (Doughty, 1973; Gephart, 1971). An analysis conducted to assist top-level administrative decision-making will differ in depth, detail, and even the kind of information provided when compared to an analysis conducted at an intermediate or lower level of responsibility. Generally speaking, the higher the level of responsibility and decision-making, the lower the amount of detail necessary and desirable in the reported data.

Variables. Given the many variables involved in analysis (e.g., alternatives, time, cost, effectiveness) consideration is typically given to fixing some set or subset of these variables in order to simplify the comparisons and control for certain types of errors. The two principal conceptual approaches are the fixed effectiveness and fixed budget (cost) approaches (Fisher, 1971, p. 10). Under the fixed effectiveness approach, the analysis is structured so that the alternatives under comparison are all assumed to reach some specified level of effectiveness and the emphasis is on determining which alternative is least costly. The fixed budget approach compares alternatives on an equal cost basis to determine the alternative which is most likely to yield the highest effectiveness (or greatest benefit utility). Multiple analyses are sometimes conducted on the same problem in order to employ both the fixed effectiveness and fixed budget approaches to make comparisons at several different levels of each.

The Office of Education (DHEW) sponsored and disseminated a handbook for evaluation practitioners entitled The Resource Approach to the Analysis of Educational Project Cost (1978), which also recommends an approach to the more typical situation where neither costs nor effectiveness are fixed. It suggests a "pair-wise comparison" (p. 68) procedure similar to that employed by Doughty and Stakenas (1973) and Lent (1976). In this situation the value judgments of the decision-maker(s) are specifically incorporated when deciding "whether or not the better outcome is worth the additional cost" (p. 69).

Elements of analysis. The analysis of any problem of choice either implicitly or explicitly involves five elements: goals, alternatives, impacts, models, and decision rules (Quade, 1975, p. 33). A goal (or

objective) is the desired state or end-point which the decision-maker wishes to realize. The alternatives are the possible means of attaining the goals. Each alternative has various impacts (cost, benefits, etc.) which accompany its choice as a means of reaching the goal. The process of determining these impacts and comparing several alternatives involves the use of one or more models to predict the consequences of the alternatives in this situation. Finally, the ultimate choice of one alternative over another depends on the use of decision rules which specify the basis upon which something is determined to be good or better than something else.

Since analysis also involves judgment it also involves certain elements of the process of judgment. These additional elements include criteria (aspects of something which are chosen as its potentially good-making or bad-making characteristics), standards (benchmarks for determining the adequacy or inadequacy of performance on a criterion), and indicators (means of determining something's performance on a criterion). Figure 1 provides a simplified example of these elements in an analysis of a problem of choice. The example was adapted from Quade (1975, p. 34).

Analysis subsystems. For each of the main elements of analysis identified above (goals, alternatives, impacts, models, and decision rules), it is possible to identify separate analysis subsystems designed to identify or accomplish the element. While most analyses do not treat each element in depth, they all do employ one or more analysis subsystems to handle the determination of impacts. Two main subsystems or impact analysis are cost analysis and effectiveness analysis.

Cost analysis involves determining the negative impacts of something and, typically, valuing the extent of those impacts in dollars. The

process of analysis is detailed and varies according to circumstances, but generally involves the examination of such factors as time, inheritance, research and development requirements, and foregone opportunities. Beilby (1977b), Belmore (1973), Doughty and Beilby (1974), Fisher (1971) and Seiler (1969) provide thorough treatments of a variety of aspects of cost analysis.

Effectiveness analysis is concerned with the positive impacts of something and particularly those positive impacts which are relevant to a judgment of the suitability of that something as a means to a given end. The analysis of effectiveness is at least as complex as cost analysis, and perhaps more so since some components of cost may vary less from situation to situation than those of effectiveness. Determining the effectiveness of something involves defining the possible impacts of something, choosing indicators to measure those impacts, and establishing standards for assigning value to performance on those measures. Specific methods of effectiveness analysis vary widely according to the nature and complexity of the decision being served by the analysis. Authors such as Carpenter and Rapp (1972), Scriven (1967), Seiler (1969), Stake (1970), and Vadhanapanich (1976) describe a range of issues and techniques that all fall under effectiveness analysis (particularly in an educational context).

A third analysis subsystem common to most complete analysis of choice is uncertainty analysis. Quade (1975, p. 213) defines uncertainty as "the unpredictabilities in factors that affect the success of a course of action." He goes on to describe the variety of ways in which different kinds of uncertainty can affect analysis and summarizes the points as follows.

OBJECTIVE:		To drive from home to work.
ALTERNATIVES:		The various routes from A to B.
MODEL:		A map of the area showing streets and freeways.
IMPACT:		Ease and cost of getting to work.
CRITERIA:	(1)	Number of miles in route.
	(2)	Average speed limit of route.
	(3)	Probability of delays due to congestion, traffic lights and stop signs.

(For judgments related to criterion (3)):

STANDARD:	The fewer the number of potential stops, the lower the probability of delay.
INDICATOR:	Number of intersections indicated by the map for each route.
DECISION RULE:	The best route is the shortest one in number of miles and travel time. (If one route is not the shortest in both mileage and time, in order to choose the best route, additional analysis is necessary to fix one side of the comparison, choose additional criteria, or weight the importance of the criteria.)

Figure 1. Elements of a simplified analysis of choice

> Therefore, uncertainty might be (a) conceptual: What precisely is the problem? (b) factual: What are the relevant facts associated with the alternatives and the current situation? (c) predictive: What changes in the situation are likely to occur before any decision can take effect? And what are the likely consequences and reactions to the alternatives between which a choice must be made? (d) strategic: What counter actions may be expected to be taken by opposing interests? (e) ethical: What should the goals be and which of the potential outcomes would be preferable in the light of those goals? (p. 217)

Some of the specific methods for dealing with uncertainty include the use of Bayesian statistics to treat probabilities in judgments, a fortiori analysis to test conclusions under specific conditions of bias, and sensitivity and contingency analysis to test the consistency of results when changing criteria, standards, indicators, and/or other components of the analysis. Techniques for handling uncertainty are discussed in documents by the American Society for Engineering Education (1971); Edwards, Guttentag, and Snapper (1975); English (1968); Fisher (1971); and Swalm (1966).

Characteristics of Cost-Effectiveness Analysis

Earlier in this chapter, cost-effectiveness analysis was briefly described in relation to other forms of analysis, i.e., systems, cost-benefit, and cost-utility. Having reviewed the characteristics that these forms of analysis hold in common, it is time to examine how they differ.

Cost-effectiveness analysis distinguished from systems analysis. The difference between systems analysis and cost-effectiveness analysis is not one of kind, but of degree or emphasis. Cost-effectiveness analysis is a particular instance of systems analysis where the predominant focus of the analysis is on comparing the cost and effectiveness of alternative approaches to a goal. Narrowly defined, cost-effectiveness analysis is

a component of systems analysis. More generally, however, cost-effectiveness analysis may expand to include all aspects of systems analysis in a particular situation.

Quade (1965a, 1975) has pointed out the differences between these broad and narrow conceptions of cost-effectiveness analysis. He describes the typical systems analysis as a very broad approach to the entire problem under consideration with cost-effectiveness analysis as just one stage.

> Thus, characteristically, a systems analysis will involve a systematic investigation of the decisionmaker's objectives and of the relevant criteria; a comparison--quantitative where possible--of the costs, effectiveness, and risks associated with the alternative policies or strategies for achieving each objective; and an attempt to formulate additional alternatives if those are found wanting. I regard the typical cost-effectiveness analysis as just one stage in this process. (1965a, p. 3)

This is "cost-effectiveness analysis" used in its most narrow or specific sense. Elsewhere Quade notes that cost-effectiveness studies may be seen more broadly as "any analytic study designed to assist a decision-maker identify a preferred choice from among possible alternatives" (1965a, p. 1), in which case the only difference between systems and cost-effectiveness analysis is in the amount of emphasis placed on impact analysis.

The distinction between systems analysis and cost-effectiveness analysis as narrowly or broadly defined is illustrated in the literature describing the conduct of cost-effectiveness studies. For example, Kazanowski (1968a, p. 115) describes cost-effectiveness analysis in the narrow sense as intended "to identify the system whose capabilities meet the mission requirements in the most advantageous manner." Thus it is assumed that the cost-effectiveness analyst works from stated goals (or mission requirements) and does not begin by exploring the situation the way a systems analysis would. Doughty and Stakenas (1973, p. 175) view cost-effectiveness analysis more broadly as designed "to relate

quantitative and qualitative data in a systematic manner to facilitate making value judgments and decisions about programs." In keeping with this broader view, they believe that the first step of cost-effectiveness analysis is a descriptive study designed to investigate characteristics of the existing situation and thereby define the goals and nature of the setting with which the analyst is to work. Doughty and Stakenas's first step in cost-effectiveness analysis thus corresponds directly with the first (or "formulation") phase of systems analysis. Aside from this difference as the beginning of analysis, both Kazanowski and Doughty and Stakenas's descriptions of the process of cost-effectiveness analysis follow Fisher's (1971) and Quade's (1975) view of the process of systems analysis.

Cost-effectiveness analysis as distinguished from cost-benefit and cost-utility analysis. One basic difference between cost-effectiveness and cost-benefit analysis rests in the nature of the decision situation being served. Following the discussions of Carman (1971, pp. 5-6) and Mayo, McAnany, and Klees (1973, p. 8), cost-benefit analysis is seen as appropriate for the larger problems facing an educational system; problems where the concern is more with what should be done than with how it should be done. Cost-effectiveness analysis is concerned with the issues of how. Of course not all authors or studies limit cost-effectiveness analysis to the study of means rather than ends, but the distinction could become meaningful in the future.

Cost-utility analysis differs from both cost-benefit and cost-effectiveness analysis on the basis of what will be considered as part of the analysis; Tuscher (1974, p. 46) points out that neither cost-effectiveness nor cost-benefit analysis involves explicit consideration

of the decision-maker's judgments of program worth or value. As a result, there is sometimes a gap between the outcomes of analysis and the subsequent actions of the decision-maker. Cost-utility analysis tries to reduce this gap by employing the decision-maker's intangible, subjective concerns in the analysis of optimal choice. Cost-utility analysis can be employed in addressing decisions that are either what or how in nature.

These differences between the three forms of analysis have ramifications for the concepts and methods employed in the analysis which thereby create further distinctions between the approaches. For example, the comparisons conducted by cost-benefit analysis require that both positive and negative impacts of alternatives be estimated on the same scale. Thus cost-benefit analysis is an economic tool with an emphasis on estimating the dollar value of everything. The nature of cost-utility analysis, meanwhile, places a corresponding emphasis on the techniques and concepts of decision theory. Finally, cost-effectiveness analysis appears to be the most methodologically varied of the three approaches since the manner of effectiveness determination depends largely on the nature of the problem and setting. For typical uses of cost-effectiveness analysis within instructional settings, the techniques of educational program evaluation play a large role (Levin, 1975). As has been previously pointed out, these three forms of analysis are alike to the extent that they are at least partially based in the techniques and concepts of economics and systems analysis.

In summary, cost-effectiveness analysis is a distinct form of analysis, but one which shares certain things in common with other analysis activities. As Quade (1975, p. 21) and others have noted, however, many of these distinctions disappear in practice.

LITERATURE REVIEW

Implications from the Literature

As stated earlier, a judgment that something is cost-effective or more cost-effective than something else involves a comparison of inputs to outcomes. Specifically, the comparison involves matching the resources expended on something (usually quantified in dollars) against the measured or estimated effectiveness of that something in achieving a particular goal or performance standard. Cost-effectiveness analysis is viewed by most as the process by which one arrives at a judgment of cost-effectiveness, and in theory, the process is straightforward and logical (see Forbes, 1974; Levin, 1975; Kazanowski, 1968a; or Alkin, 1970; for a general introduction to the approach). Problems arise, however, when this technique is applied within an educational context. As Levin (1971) has pointed out, we know so little about the nature and relationships between educational inputs and outputs that the possibilities for valid conclusions about cost-effectiveness are severely limited.

Difficulties facing cost-effectiveness analyses in education also apply to similar analyses of instructional technology since its worth can only be judged upon its performance within an educational context. Most reported attempts to analyze the cost-effectiveness of instructional technology have therefore been of rather limited success or of limited utility.

Most studies reviewed here have avoided the complex issues surrounding the judgment of the effectiveness of instructional technology in achieving some educational outcome by falling victim to one or more of the following pitfalls:

(1) They focus only on inputs,
(2) They focus only on costs (and not effectiveness),
(3) They rely upon misleading thruput indicators or proxies as measures of outcomes or productivity (such as cost per student credit hour), or
(4) They rely upon single outcome focus as evidence of effectiveness.

More comprehensive considerations of pitfalls have been reported by Doughty (1979) and Kazanowski (1968b) but these four appear to be most pervasive. Brief comments on each are sufficient for the purposes of this report.

(1) Studies which focus on inputs can be most easily observed in the many media comparison studies reported. These are usually investigations of changes in specific instructional media or techniques. Typically these studies are structured around a substitution of a new approach (e.g., instructional television) for an old approach (e.g., conventional classroom lectures). Whatever was used as an outcome measure for the old approach (preferably something quantifiable, i.e., a final exam) is used as the outcome measure for the new approach. Little attempt is made to determine or compare the differing outcomes of the two approaches. The relationships between inputs and outcomes are assumed to be linear and univariate.

(2) Studies which focus only on costs.

Some studies stress the requirement for cost-effectiveness judgments--but then proceed to focus only on costs leaving the effectiveness issues to the judgments of the local decision makers (e.g., Jamison & Klees, 1975) or they cite the "no-significant difference" research and claim that therefore the choices can be made on the basis of cost alone (Caffarella, 1978a; Morris, 1974). At this point a sizeable literature has grown up around the cost-analysis of instructional

technology (IT) (e.g., Wagner, 1975; Wilkinson, 1973; Chappell, 1970) and some work has been done to summarize this research and develop some general principles (e.g., Caffarella, 1975b; General Learning Corp., 1968; Johnson & Dietrich, 1971) for IT-focused practice.

(3) Studies which rely upon misleading thruput indicators. The majority of cost analysis or unit cost studies (Witmer, 1972) conducted in higher education employ the standard unit of measure--the credit hour--as the measure of outcome or productivity. Rarely is this metric identified as a weak proxy or indicator of outcomes. Frequently this measure of student flow or thruput is combined with a cost figure to become a ratio of cost to or per student credit hour produced. Discussions between legislators and academics about the quality and productivity of higher education often include reference to a "high" cost-per-student-hour figure as an indicator of quality or inefficiency when in fact it may be neither. The fact that such ratios presently serve as primary data for decision-making in higher education should give cause for concern.

(4) Studies that rely upon single outcome measures as evidence of effectiveness. Envision the many evaluation studies of instructional methods or strategies that reported significant statistical and educational differences in achievement as measured by the X standardized test. Conveniently ignored was compelling evidence that those same high achievers began the study as eager learners and left as hostile students who

no longer care to pursue that subject or skill any further. The more enlightened program evaluation models, conbined with functional cost analysis methods (Beilby, 1977a, 1977b) are helping considerably to eliminate this pitfall as well as the others previously mentioned.

While much of this current literature is a valuable contribution to the state of the art, it falls short of providing evidence on the cost-effectiveness of instructional technology in two ways.

(1) It fails to deal simultaneously with costs and effectiveness in comparing alternatives, and it
(2) Fails to examine the C-E of IT when IT is defined as a systematic approach to instruction--rather than a collection of media techniques.

Attempts to actually conduct cost-effectiveness evaluation of IT are continually confronted with the challenge of comparing the cost-effectiveness of alternatives when using multiple criteria of effectiveness. Attempts to do so usually rely on a matrix approach which displays the data on the various criteria and leaves the final determination to the decision maker. Attempts to infer any causal relationships between resources expended and results obtained are almost certain to be lost causes. Studies reported by Miller (1971), Doughty (1973), and Lent (1976) are examples of state-of-the-art methodology which do not attempt to make any causal links.

Attempts to examine the cost-effectiveness of a systematic approach to instructional technology have in recent years come to mean more than the application of assorted media in educational contexts. In the words of the Commission of Instructional Technology (1970) it is coming to be defined as "a systematic way of designing, carrying out, and evaluating the total process of lea ning and teaching in terms of specific objectives,

based on research in human learning and communication, and employing a combination of human and nonhuman resources to bring about more effective instruction" (p. 19). When the IT field is considered from the perspective of this definition, the problems of conducting cost-effectiveness analysis multiply. Such questions arise as, What are you analyzing, the process or its products? We now have the additional problem of determining the relationships betwe.. the application of this systematic process and changes in the inputs... as well as relationships between inputs and outputs. The conceptual complexity and number of unknowns in this arena is thus much greater.

There is almost no existing research in this area. Diamond et al. (1975) and Pearson (1972) have discussed some of the problems and possible models for work in this area. Belmore (1972) has reported his attempts at the cost analysis problems. Doughty and Stakenas (1972) have provided one of the few documented attempts to conduct a comprehensive cost-effectiveness analysis of a systematic instructional project. Perhaps the considerable resources required to conduct such studies deters others from advancing research in this area, but if the power of technology is in systems focused applications, then the assessment of those applications will require complex models of evaluation and cost-effectiveness analysis.

Future Prospects

The complexity of the problem facing both appliers of instructional technology and assessors of those applications must not discourage would-be researchers and analysts. There is a need for more substantive case studies of the cost-effectiveness of instructional technology and

instructional development such that better operational heuristics can be developed. In addition, these studies can also contribute to the research and theory bases of both C-E and IT, as well as helping us to better understand what it means to be accountable.

Other issues are evident in the literature, such as determining when it is advisable (cost-effective) to conduct a comprehensive C-E analysis. There is also the call for guidance in helping to determine when the notion of "economy of scale" is an important factor in IT and C-E applications. More technical issues to be considered should include a shift from the emphasis on average costs to marginal or incremental costs--an important factor in C-E driven decisions. And perhaps the most important perspective for the study of instructional technology is the use of lifetime dollar costs as the basis for input comparisons rather than relying upon single cycle operational expenditures which oftentimes mask many of the actual costs of conventional instructional alternatives, as well as improperly distributing the start-up expenses of new innovative programs.

The following references have thus been selected primarily on the basis of their contribution (or potential contribution) to advancing the practice of cost-effectiveness evaluation and analysis in instructional technology. Although many of the papers, reports and documents have been included in the ERIC system, that circumstance had little impact on our selections. However, in those instances where references of similar focus emerged, then the easy accessibility of ERIC documents served as a selection factor.

It is important here to acknowledge again the considerable and growing number of references in the ERIC system that embrace these two

areas of interest. To assume that our collective experience and wisdom in the areas ensures the presence of all the best relevant documents in this report is unwise. To locate even better examples of applications or more fundamentally sound guidance on C-E methods is everyone's goal. We trust that our colleagues in the ERIC netowrk will continue to assist us in that search--and vice-versa.

ANNOTATED BIBLIOGRAPHY ON COST-EFFECTIVENESS AND INSTRUCTIONAL TECHNOLOGY

It is useful to organize a bibliography in such a way that users can instantly identify those references that match their entry level knowledge and current interests. It was decided to organize the annotated cost-effectiveness bibliography under seven headings which collectively represent a general progression through a logical development of an economic analysis study from conceptual and theoretical concerns through to hard-edged outcomes. The seven headings are:

(1) Concepts
(2) General and Theoretical Approaches
(3) Modeling Activities
(4) Cost Analysis
(5) Outcomes: Effectiveness and Benefits
(6) Reviews and Critiques
(7) Case Studies

This logical framework is attractive, but in many cases the actual references do not fall clearly into only one category. Several covered all the categories. To avoid the boring, and visually confusing repetition of references and op. cit., the bibliography is presented in two sections: General References (Part I) and Case Studies (II). Nevertheless, a device which will enable the reader to identify interest areas has been built into the bibliography: a number or series of code numbers occurs at the end of the annotation for each entry in the bibliography. These numbers--1,2,3,4,5,6--refer to the corresponding categories given above. Thus a reference followed by a 1, 3, and 4 indicates that it addresses Concepts (1), Modeling Activities (2), and Cost Analysis (4).

It is hoped that this simple organization will increase the effectiveness and utility of the bibliography.

BIBLIOGRAPHY

Part I - General References

Carpenter, P. Cost-effectiveness as an aid to making decisions in education. Santa Monica, CA: Rand, 1970. (P-4517) (1,3)

Carpenter, M.B., Chester, L.G., Dordick, H.S. and Haggart, S.A. Analyzing the use of technology to upgrade education in a developing country. Santa Monica, CA: Rand, 1970 (RM-6179-RC)

Two studies which demonstrate the application of systems analysis techniques to educational planning, and the potential usefulness of technology (especially ETV) in education in a developing country (Colombia). Four alternatives for the future and potential upgrading of Colombia's primary and secondary education systems were analyzed. (1,3)

Coombs, P.H. and Hallak, J. Managing educational costs. New York: Oxford University Press, 1972.

UNESCO's International Institute of Educational Planning funded a project to examine the use of educational cost analysis in various planning efforts. Twenty-seven case studies were eventually completed and reported in three volumes as Educational cost analyses in action: Case studies for planners. The Coombs and Hallak book represents a synthesis of the conclusions and principles reached through these case studies. (1,4,5)

Defense Economic Analysis Council, Handbook Committee. Economic analysis handbook (2nd ed.). Washington, DC: U.S. Department of Defense, undated.

Provides a set of procedures to guide the uninitiated through the major phases of an economic analysis. Describes several costing methods and explains basic, relevant concepts. (1,3,4)

Doughty P.L. Cost effectiveness analysis tradeoffs and pitfalls for planning and evaluating instructional programs. Journal of Instructional Development, 2, (4), 1979.

The first article in a series on cost-effectiveness. Provides an overview of conceptual and practical criteria for judging and designing cost-effectiveness studies. (1,2)

Doughty, P.L. and Beilby, A. Cost analysis and teacher evaluation: A comment on relevant relationships and a review of existing models. Albany, NY: The State Education Department, Division of Teacher Education and Certification, 1974.

Describes the system's context of cost analysis, reviews 19 cost

analysis studies and proposes a cost model for use in teacher education. (1,2,3,4,6)

Doughty, P.L. and Stakenas, R.G. An analysis of costs and effectiveness of an individualized subject offering. In C.D. Sabine (Ed.), Accountability: Systems planning in education. Homewood, IL: ETC, 1973.

An investigation to develop and explicate methods for analyzing the costs, effectiveness and feasibility of instructional alternatives. Results from a descriptive analysis were used in predictive comparison which considered four future alternatives for course design: traditional small group instruction, conventional large group lecture-lab, individualized course with locally developed materials, and individualized course with commercially prepared materials. (3,4)

Doughty, P.L., Stern, H.W. and Thompson, C. Guidelines for cost-effectiveness analysis for navy training and education. San Diego, CA: Navy Personnel Research and Development Center, 1976 (Special Report 76TQ-12).

Guidelines and procedures are presented to assist analysts and evaluators in determining when a cost-effectiveness study is feasible and appropriate, how best to conduct the analysis, what type of components to consider, and what kinds of answers to expect. Checklists, a Navy C-E case study and an annotated bibliography are also included. (1,2,3,4,5,6)

Eckstein, O. Water resource development. Cambridge, MA: Harvard University Press, 1961.

Classic work in the field of cost-effectiveness analysis. The first four chapters examine the theory of welfare economics as it applies to project evaluation. The remaining six chapters apply the theory to various aspects of water resource development. (1,2)

Fielden, J. and Pearson, R.K. Costing educational practice. London: Council for Educational Technology, 1978.

A handbook designed to describe how to do cost analyses. The case studies report cost analyses of a driver training program for the RAF, the reorganization of a university's laboratory course in biology, self-instructional units in college-level science, and several other innovative instructional projects. (1,4)

Fisher, G.H. Cost considerations in system analysis. New York: American Elsevier, Inc., 1971.

Concepts and principles of systems analysis and cost analysis are defined in first three chapters while more explicit applications, examples, and military oriented problems are discussed in the remaining six chapters. (1,2,3,4)

Haller, E.J. Cost analysis for educational program evaluation. In W.J. Popham (Ed.), Evaluation in education. Berkeley, CA: McCutchan Publishing, 1974.

An introduction to cost analysis concepts such as life cycle, relevant costs and marginal costs. Contains recommendations for measuring costs. (1,3,4)

Jamison, D.T., Klees, S.J., and Wells, S.J. The costs of educational media: Guidelines for planning and evaluation. Beverly Hills, CA: SAGE, 1978.

Summarizes various evaluation studies of the costs of instructional radio and television projects and offers a description of the methods and problems of educational cost analysis. Consideration is given to capital costs, student utilization over time, opportunity costs, shadow prices, the perspectives of decision-makers at different levels, and certain sources of error in cost estimation. (1,4,5)

Layard, R. (Ed.) Cost benefit analysis. Baltimore, MD: Penguin Books, Ltd., 1972.

Excellent anthology of important articles presenting theoretical basis of cost-benefit analysis including issues of benefit measurement, time preference, social opportunity cost, and treatment of risk. (2)

Lent, R.M. A model for applying cost-effectiveness analysis to decisions involving the use of instructional technology. Journal of Instructional Development, 3, (1), 1979.

Part of a series of articles on cost-effectiveness and cost analysis. This article provides a detailed model of the methods of cost-effectiveness analysis as used to inform decisions about instructional development efforts and other applications of educational technology. (1,2,3)

Levin, H.M. Cost effectiveness analysis in evaluation research. In M. Guttentag (Ed.), Handbook of evaluation research, Vol. 2. Beverly Hills, CA: SAGE, 1975.

A useful and clear treatment of cost-effectiveness. Introduces several economic concepts and discusses basic concerns relative to measuring effectiveness. (1,2,3,5)

McKean, R.N. Efficiency in government through systems analysis. New York: John Wiley and Sons, Inc., 1958.

One of the classics in the area of benefit-cost analysis. Primary applied attention is given to water resource decisions. (1,2,5)

NCHEMS Publications: Various works published by the Western Interstate Commission on Higher Education (WICHE), National Center for Higher Education Management (NCHEMS), present systematic procedures and practices for allocating costs and outcomes in higher education institutions. List of publications available from WICHE, Post Office Drawer P, Boulder, Colorado 80302. (3,4,5)

Page, E.B. Seeking a measure of general educational advancement. The Bentee. Journal of Educational Measurement, Spr 1972.

An attempt to define a universal outcome measure. Raises issues concerned with values and measurement. (1,2)

Quade, E.S. Analysis for public decisions. New York: American Elsevier, 1975.

Presents the concepts and procedures that comprise an analytical approach to decision-making. The framework for conducting analyses includes the following steps: (1) clarification of the problem; (2) identification of the objectives; (3) measurement of effectiveness; (4) determination of a criterion; (5) formulation of models; (6) data collection; (7) carrying out the comparison; (8) examination of the analysis for sensitivities; (9) consideration of deficiencies in the analysis; and (10) summarizing and, where appropriate, making recommendations. (1,2,3)

Schramm, W. Big media little media: Tools and technologies for instruction. Beverly Hills, CA: SAGE, 1977.

Chapter Four, "The Economic Evidence" (pp. 105-139), is particularly useful as a general review of the costs of instructional media. Intended as a companion piece to the Jamison et al. (1978) text. (4)

Seiler, K. Introduction to systems cost-effectiveness. New York: Wiley-Interscience, 1969.

Though intended for readers with a basic understanding of calculus and probability theory, issues and concepts are well described verbally. Specific sections focus on cost related issues, system cost models, an effectiveness model, and various comprehensive cost effectiveness analysis models. (1,2,3,4)

Stakenas, R.G. and Kaufman, R. Costs and effectiveness of technological application in education: A literature review. Tallahassee, FL: Florida State University, Instructional Systems Development Center, 1977. ED 169 922.

An analysis of the findings from other studies concerned with technological applications in education. A good source for identifying other studies. (5,6)

Temkin, S. Making sense of benefit-cost analysis and cost-effectiveness analysis. Improving Human Performance: A Research Quarterly, Sum 1974.

A critical look at the language and assumptions of the two methods. Attempts to explain the methods in relatively untechnical terms. (1,2)

Temkin, S. and McNamara, J.F. A comprehensive planning model for school districts: Decision rules and implementation strategies. Journal of Educational Administration, Oct 1973.

A planning model that incorporates cost and effectiveness information is proposed. (Parts of the model were adapted by several school districts in the 1968-73 period.) (1,3,5)

Wilkinson, G.L. Cost evaluation of instructional strategies. Audiovisual Communications Review, 21, (1), 1973.

One of the first articles to present a conceptually sound rationale for cost-effectiveness as a methodology in the evaluation of instruction. Distinctions are made between various alternative cost analysis and cost evaluation techniques and the argument for cost-effectiveness analysis is presented. (1,2,3,4)

Wilkinson, G.L. Economic evaluation in/or instructional development. In R.K. Bass and D.B. Lumsden (Eds.), Instructional development: The state of the art. Columbus, OH: Collegiate Publishing, 1978.

This chapter includes discussions about the concepts relevant to many types of analyses in instructional development contexts, as well as more detailed descriptions of cost-effectiveness and cost-benefit evaluation. (1,4)

Part II - Case Studies

Public School Case Studies

Belmore, W.E. The application of a cost analysis methodology to the design phase of instructional development (Doctoral dissertation, Indiana University, 1973). Dissertation Abstracts International, 1974, 33, 5996-A. (University Microfilms No. 73-10,756)

The development and testing of a functional cost analysis procedure. Cost data were collected only for the design phase.

Ernst and Ernst. A model for the determination of the costs of special education as compared with that for general education. Chicago, IL: Ernst and Ernst, Feb 1974.

A model for determining special education costs. Includes some empirical work and employs an accounting perspective. (1,3,4,5)

Gailitis, M.M. The costs of information retrieval television: A case study in the cost-effectiveness of educational media. (Occasional Paper No. 12). Toronto: Ontario Institute for Studies in Education, 1972.

A detailed study of the cost and cost-effectiveness of an information retrieval television (IRTV) system when compared to other systems for delivering a similar service. The study provides both descriptive and predictive comparative analyses of system cost per unit of system performance (defined as system use).

Michigan Department of Education. Research, Evaluation and Assessment Services. Report of the 1974-75 Michigan cost-effectiveness study. Washington, DC: Capital Publications, Inc., Educational Resources Division, 1976. 177p. ED 134 634.

A study to identify factors that contribute to more effective and efficient special educational delivery systems. (3,5,7)

Rorro, C.M. A cost study analysis of school district implementation of T&E in New Jersey, 1978. (Unpublished doctoral dissertation at Fairleigh-Dickinson).

A study of costs incurred by 42 school districts in New Jersey as they implemented the goal setting phase of the state's T&E approach to school improvement. (4,7)

Post Secondary Education Case Studies

Baley, J.D. Cost effectiveness of three methods of remedial instruction in mastery learning and the relationship between aptitude and

achievement. (Doctoral dissertation, University of Southern California, 1972). Dissertation Abstracts International, 1973, 33, 3475-A. (University Microfilms No. 73-716)

A study comparing the relative cost effectiveness of three methods of remedial instruction in mathematics and tutorial assistance by the course instructor. (1)

Beilby, A. A functional cost analysis process applied to selected competency-based teacher education programs in New York State. (Doctoral dissertation, Syracuse University, 1977). Dissertation Abstracts International, 1978, 39, 554-A. (University Microfilms No. 7811633)

The development and test of a functional cost analysis procedure.

Beilby, A.E. Costing instructional programs. Ithaca, NY: Cornell University, Cornell Institute for Occupational Education, 1978. 103p. ED 165 333.*

Introduces functional cost analysis and life-cycle costing concepts. Two detailed case studies of two-year college instruction programs are presented. (1,3,4,5)

Doughty, P.L. Effectiveness, cost, and feasibility analysis of a course in college level geology. (Doctoral dissertation, Florida State University, 1972). Dissertation Abstracts International, 1973, 33, 5467-A. (University Microfilms No. 73-10, 325)

Compares four instructional approaches (including lecture-lab and individualized audio-tutorial) in a university setting as a means of validating a cost-effectiveness model. (1,2,3,4,5)

Enos, D.F. A cost-effectiveness analysis of competency and non-competency based teacher education at San Diego State University (Doctoral dissertation, University of Texas at Austin, 1976). Dissertation Abstracts International, 1976, 37, 2793-A. (University Microfilms No. 76-26, 625).

A comparison of the cost and effectiveness of two means of preparing prospective elementary school teachers at San Diego State University.

Lent, R.M. Planning for future University College programs. A cost-effectiveness evaluation of alternative instructional delivery systems. Syracuse, NY: University College of Syracuse University, 1976. 120p. ED 142 195.

Lent, R.M. Program planning and the cost-effectiveness analysis of instructional technologies: A case study in planning continuing education services. Paper presented at the annual meeting of the American Educational Research Association, New York City, 1977. 49p. ED 145 801.

These papers explore the strengths and weaknesses of alternative systems for delivering continuing education courses to students in central New York. The evaluation was conducted within a framework of six costs and effectiveness criteria with the performance of the alternatives compared on a Cost-Effectiveness Comparison Matrix.

Military Case Studies

Beilby, A.E., Locatis, C., Marvin, M., and Wilbur, F. An economic analysis of TRADOC's basic non-commissioned officers course for the combat arms program. Fort Monroe, VA: U.S. Army Training and Doctrine Command, 1978.

The primary objective of this study was to provide decision makers with data to enable them to select the most cost-effective combination of non-commissioned officer training site locations to meet Army cost and defense strategy goals. A secondary objective of the study was to identify problems which may have existed with the design, development and delivery of officers' training. Specific recommendations were made regarding optimal class size, establishment of training locations, development of indicators of course effectiveness, adoption of alternate instructional systems and materials, and other issues relating to maximizing the efficiency of instruction. (1,4)

Temkin, S., Connolly, J., Marvin, M., Valdes, A., and Caviness, J. An economic assessment of Army training alternatives. Arlington, VA: Army Research Institute, 1975.

A study of the costs of the use of an audiovisual training approach compared with those of conventional instruction in the Army. (3,4,5,7)

International Case Studies

Coombs, P.H. and Hallak, J. Educational cost analysis in action: Case studies for planners - I, II, III. Paris: UNESCO International Institute for Educational Planning, 1972b. Vol. I, 356p., ED 082 337*; Vol. 2, 270p., ED 082 338*; Vol 3, 343p., ED 082 339.*

A three volume series of cost analysis case studies conducted of educational projects throughout the world. Companion pieces to the synthesis report Managing educational costs (Coombs & Hallak, 1972a). (7)

Mayo, J.K., McAnany, E.G., and Klees, S.J. The Mexican Telesecundaria: A cost-effectiveness analysis. Stanford, CA: Stanford University Institute for Communication Research, 1973. 173p. ED 076 059.

Mayo, J.K., McAnany, E.G., and Kleés, S.J. The Mexican Telesecundaria: A cost-effectiveness analysis. Instructional Science, 1975, 4, 193-236.

An evaluation of a six-year old project designed to provide secondary education to rural students in Mexico through the use of television. The evaluation compared this project, the Telesecundaria system, against the traditional secondary education system, Ensenanza Directa, on a number of cost and effectiveness variables. Telesecundaria was found to be comparatively inexpensive, effective, and efficient in fulfilling its functions.

REFERENCES

Alkin, M.C. Evaluating the cost-effectiveness of instructional programs Report No. 25. Los Angeles: Center for the Study of Evaluation, May 1969. 36p. ED 031 818.

Alkin, M. Evaluating net cost-effectiveness of instructional programs. In M.C. Wittrock and D.E. Wiley (Eds.), The evaluation of instruction. New York: Holt, Rinehart, and Winston, 1970.

American Society for Engineering Education. Decision and risk analysis. (Summer Symposium Series VI). Washington, DC: Author, 1971.

Association for Educational Communications and Technology. The field of instructional technology: A statement of definition. Audiovisual Instruction, 1972, 17 (8).

Baley, J.D. Cost-effectiveness of three methods of remedial instruction in mastery learning and the relationship between aptitude and achievement. (Doctoral dissertation, University of Southern California, 1972.) Dissertation Abstracts International, 1973, 33, 3475-A. (University Microfilms No. 73-716)

Barson, J. and Jones, G.M. A procedural and cost analysis study of media in instructional systems development. 279p. ED 011 959.

Beilby, A.E. A functional cost analysis of selected competency based teacher education programs in New York State. (Doctoral dissertation, Syracuse University, 1977). Dissertation Abstracts International, 1978, 39, 554-A. (University Microfilms No. 7811633)

Beilby, A.E. Application of an alternative cost analysis model to educational programs. Paper presented at the annual meeting of the American Educational Research Association, New York, 1977b. 50p. ED 137 931.

Beilby, A.E., Locatis, C., Marvin, M., and Wilbur F An economic analysis of TRADOC's basic non-commissioned officers course for the combat arms program. Fort Monroe, VA: U.S. Army Training and Doctrine Command, 1978.

Belmore, W.E. The application of a cost analysis methodology to the design phase of instructional development. (Doctoral dissertation, Indiana University, 1972). Dissertation Abstracts International, 1973, 33, 5996-A. (University Microfilms No. 73-10, 756)

Bertalanffy, L. von. General system theory: Foundations, development, application. New York: Braziller, 1968.

Caffarella, E.P. The cost-effectiveness of instructional technology: A propositional inventory of the literature. (Doctoral dissertation, Michigan State University, 1973). Dissertation Abstracts International, 1973, 34, 5510-A - 5511-A. (University Microfilms No. 74-6019)

Caffarella, E.P. How little do we know about the cost-effectiveness of instructional technology? Educational Technology, 15 (Jan), 1975a, 56-58.

Caffarella, E.P. A propositional statement on the cost-effectiveness of instructional technology. Paper presented at the annual meeting of the American Educational Research Association, Washington, DC, 1975b. ED 104 278.

Caldwell, M.S. An approach to the assessment of educational planning. Educational Technology, 1968, 8, (Oct), 5-12.

Carman, R.A. Cost-effectiveness analysis of various methods of instruction in developmental mathematics. Santa Barbara, CA: Santa Barbara City College, 1971. 39p. ED 057 793.

Carnegie Commission on Higher Education. The fourth revolution: Instructional technology in higher education. New York: McGraw-Hill, 1972.

Carnoy, M. The economic cost and returns to educational television. In G.V. Glass (Ed.), Evaluation studies review annual. Beverly Hills, CA: SAGE, 1976.

Carnoy, M. and Levin, J.M. Evaluation of educational media: Some issues. Instructional Science, 4, 1975; 385-406.

Carpenter, P. Cost-effectiveness as an aid to making decisions in education. Santa Monica, CA: RAND, Dec 1970. (P-4517)

Carpenter, M.B., Chester, L.G., Dordick, J.S., and Haggart, S.A. Analyzing the use of technology to upgrade education in a developing country. Santa Monica, CA: RAND, Mar 1970. (Research Memorandum RM-6179-RC)

Carpenter, M.B. and Haggart, S.A. Cost-effectiveness analysis for educational planning. In S.A. Haggart (Ed.), Program budgeting for school district planning. Englewood Cliffs, NJ: Educational Technology, 1972.

Carpenter, M.B. and Rapp, M.L. The analysis of effectiveness. In S.A. Haggart (Ed.), Program budgeting for school district planning. Englewood Cliffs, NJ: Educational Technology, 1972.

Chappell, W.G. A model for predicting the unit cost of developing self-instructional materials in higher education biological and physical sciences. (Doctoral dissertation, Michigan State University, 1970). Dissertation Abstracts International, 1970, 32, 116-A. (University Microfilms No. 71-18,183)

Cogan, E. Systems analysis and the introduction of educational technology in schools. In S.G. Tickton (Ed.), To improve learning: An evaluation of instructional technology. (Vol. II). New York: Bowker, 1971.

Commission on Instructional Technology, S.M. McMurrin (Chair). To improve learning: A report by the Commission on Instructional Technology. In S.G. Tickton (Ed.), To improve learning: An evaluation of instructional technology (Vol. I). New York: Bowker, 1970.

Committee for Economic Development. Innovation in education: New directions for the American school. New York: Author, 1968.

Coombs, P.H. and Hallak, J. Educational cost analysis in action: Case studies for planners - I, II. Paris: UNESCO, International Institute for Educational Planning, 1972a. ED 082 337* - 082 338.*

Coombs, P.H. and Hallak, J. Managing educational costs. New York: Oxford Press, 1972b.

Davies, I.K. and Schwen, T.M. Toward a definition of instructional development. Occasional papers. Papers presented to the Instructional Development Division of the Association for Educational Communications and Technology, Philadelphia, Mar 1971.

Diamond, R.M., Eickmann, P.E., Kelly, E.F., Holloway, R.M., Vickery, T.R. and Pascarella, E. Instructional development for individualized learning in higher education. Englewood Cliffs, NJ: Educational Technology, 1975.

Doughty, P.L. Cost effectivensss analysis tradeoffs and pitfalls for planning and evaluating instructional programs. Journal of Instructional Development, 2, (4), 1979.

Doughty, P.L. Effectiveness, cost, and feasibility analysis of a course in college level geology. (Doctoral dissertation, Florida State University, 1972), Dissertation Abstracts, 1973, 33, 5467-A. (University Microfilms No. 73-10,325)

Doughty, P.L. and Beilby, A. Cost analysis and teacher education: A comment on relevant relationships and a review of existing models. Albany, NY: The State Education Department, Division of Teacher Education and Certification, 1974.

Doughty, P.L. and Stakenas, R. An analysis of costs and effectiveness of an individualized subject offering. In C.D. Sabine (Ed.), Accountability: Systems planning in education. Homewood, IL: ETC, 1973.

Doughty, P.L., Stern, H.W. and Thompson, C. Guidelines for cost-effectiveness analysis for navy training and education. San Diego, CA: Navy Personnel Research and Development Center, 1976. (Special Report 76TQ-12)

Dror, Y. Systems analysis for development decisions. Applicability, feasibility, effectiveness and efficiency. Santa Monica, CA: RAND, Aug 1969. (P-4159)

Dubin, R. and Hedley, R.A. The medium may be related to the message: College instruction by TV. Eugene, OR: Center for the Advanced Study of Educational Administration, 1969. 125p. ED 031 926.

Edwards, W., Guttentag, M., and Snapper, K. A Decision-theoretic approach to evaluation research. In E.L. Struening and M. Guttentag (Eds.), Handbook of evaluation research, (Vol. I). Beverly Hills, CA: Sage, 1975.

English, J.M. Cost-effectiveness analysis of competency-based and non-competency based teacher education at San Diego State University. (Doctoral dissertation, University of Texas at Austin, 1976). Dissertation Abstracts International, 1976, 37, 2793-A (University Microfilms No. 76-26,625)

Ernst and Ernst. A model for the determination of the costs of special education as compared with that for general education. Chicago: Ernst and Ernst, Feb 1974.

ERIC Reports. Selected ERIC bibliography: cost-effectiveness of instructional technology. Educational Technology, Jan 1977, 57-61.

Fisher, G.H. Cost considerations in systems analysis. New York: American Elsevier, 1971.

Forbes, R.H. Cost-effectiveness analysis: Primer and guidelines. Educational Technology, 1974, 14 (Mar), 21-26.

Gailitis, M.M. The costs of information retrieval television: A case study in the cost-effectiveness of educational media. (Occasional Papers No. 12). Toronto: Ontario Institute for Studies in Education, 1972.

General Learning Corporation. Cost study of education media systems and their equipment components. 3 vols. Washington, DC: Author, 1968.

Gephart, W.J. Decision levels: A neglected factor in cost-benefit analyses. Educational Technology, 1971, 11 (Sept), 60-61.

Grayson, L.P. Costs, benefits, effectiveness: Challenge to educational technology. Science, 1972, 175, 1216-1222.

Grosse, R.N. Preface. In T.A. Goldman (Ed.), Cost-effectiveness analysis. New York: Praeger, 1967.

Haggart, S.A. (Ed.). Program budgeting for school district planning. Englewood Cliffs, NJ: Educational Technology, 1972.

Haggart, S.A. The resource approach to the analysis of educational project cost. Washington, DC: Department of Health, Education and Welfare, 1978.

Haller, E.J. Cost analysis for educational program evaluation. In W.J. Popham (Ed.), Evaluation in education. Berkeley, CA: McCutchan, 1974.

Heinich, R. What is instructional technology? Audiovisual Instruction, 13 (Mar), 1968, 222.

Hitch, C.J. and McKean, R.N. The economics of defense in the nuclear age. Cambridge: Harvard University Press, 1963.

Hu, T., Lee, M.L., and Stromsdorfer, E.W. A cost-effectiveness study of vocational education. University Park, PA: Institute for Research on Human Resources, The Pennsylvania State University, 1969. 317p. ED 029 093.

James, H.T. Financing more effective education. In Committee for Economic Development, The schools and the challenge of innovation. New York: McGraw-Hill, 1969.

Jamison, D.T. and Klees, S.J. The cost of instructional radio and television for developing countries. Instructional Science, 4, 1975, 333-384.

Jamison, D.T., Klees, S.J. and Wells, S.J. Cost analysis for educational planning and evaluation: Methodology and application to instructional technology, Princeton, NJ: Educational Testing Service, 1976. 305p. ED 127 918.

Jamison, D.T., Suppes, P. and Wells, S. The effectiveness of alternative instructional media: A survey. Review of Educational Research, 44, (1), 1974, 1-67.

Johnson, F.C. and Dietrich, J.E. Cost analysis of instructional technology. In S.G. Tickton (Ed.), To improve learning: An evaluation of instructional technology. NY: Bowker, 1971.

Kazanowski, A.D. A standardized approach to cost-effectiveness evaluations. In J.M. English (Ed.), Cost-effectiveness: The economic evaluation of engineered systems. New York: Wiley, 1968a.

Kazanowski, A.D. Cost-effectiveness fallacies and misconceptions revisited. In J.M. English (Ed.), Cost-effectiveness: The economic evaluation of engineered systems. New York: Wiley, 1968b.

LaPlaca, N.A. A cost-effectiveness analysis of individual learning units in a junior high school basic mathematics program. (Doctoral dissertation, University of the Pacific, 1973.) Dissertation Abstracts International, 34, 3771-3772A. (University Microfilms No. 73-32098)

Layard, R. The cost-effectiveness of the new media in higher education. In K.G. Lumsden (Ed.), Efficiency in universities: The La Paz papers. Amsterdam: Elsevier, 1974.

Lent, R.M. Planning for future University College programs: A cost-effectiveness evaluation of alternative instructional delivery systems. Syracuse, NY: University College of Syracuse University, 1976. 120p. ED 142 195.

Lent, R.M. Program planning and the cost-effectiveness analysis of instructional technologies: A case study in planning continuing education services. Paper presented at the annual meeting of the American Educational Research Association, New York, 1977. 49p. ED 145 801.

Lent, R.M. A model for applying cost-effectiveness analysis to decisions involving the use of instructional technology. Journal of Instructional Development, 2, (5), 1979.

Levin, H.M. Cost-effectiveness evaluation of instructional technology: The problems. In S.G. Tickton (Ed.), To improve learning: An evaluation of instructional technology, Vol. II. New York: Bowker, 1971.

Levin, H.M. Cost-effectiveness analysis in evaluation research. In M. Guttentag and E.L. Struening (Eds.), Handbook of evaluation research, Vol. II. Beverly Hills, CA: Sage, 1975.

Levin, H.M. Cost and economic aspects of evaluation: A grand illusion. Evaluation News, 1978, 8, 39-45.

Lovell, N.B. Cost-effectiveness evaluation of instructional programs: A developmental design (K-12). (Doctoral dissertation, Florida State University, 1971). Dissertation Abstracts International, 1972, 32, 6051-A. (University Microfilms No. 72-13,584)

Lumsden, K.G. Efficiency in universities: The La Paz papers. Amsterdam: Elsevier, 1974.

Marinelli, J.J. An analytical process model for cost-effectiveness productivity evaluation of alternative educational programs. (Doctoral dissertation, University of Wisconsin, 1976). Dissertation Abstracts International, 1976, 37, 3405-3406A (University Microfilms No. 76-20,908)

Mayo, J.K. and Klees, S.J. Extending the school with television: The case of Mexico's Telesecundaria. Paper presented at the annual meeting of the American Educational Research Association, Chicago, 1974. 38p. ED 090 988.

Mayo, J.K., McAnany, E.G., and Klees, S.J. The Mexican Telesecundaria: A cost-effectiveness analysis. Palo Alto: Stanford University Institute for Communication Research, 1973. 173p. ED 076 059.

Mayo, J.K., McAnany, E.G. and Klees, S.J. The Mexican Telesecundaria: A cost-effectiveness analysis. Instructional Science, 4, 1975, 193-236.

McCullough, J.D. Cost effectiveness: Estimating system costs. Santa Monica, CA: RAND, Sept 1965. (P-3279).

McKean, R.N. Efficiency in government through systems analysis. New York: Wiley, 1958.

Meeth, L.R. Quality education for less money. San Francisco, CA: Jossey-Bass, 1975.

Michigan Department of Education, Research, Evaluation and Assessment Services. Report of the 1974-75 Michigan cost-effectiveness study. Washington, DC: Educational Resources Division, Capital Publications, Inc., 1976. 177p. ED 134 634.

Miller, J.G. Deciding whether and how to use educational technology in the light of cost-effectiveness evaluation. In S.G. Tickton (Ed.), To improve learning: An evaluation of instructional technology (Vol. II). New York: Bowker, 1971.

Morris, A.J. (Chair). Final report of the cost-effectiveness of continuing engineering studies by televison. Washington, DC: American Society of Engineering Education, 1974. 44p. ED 093 360.

Mulvihill, P.J. Cost-effectiveness study of regional instructional materials centers. Harrisburg, PA: Pennsylvania Department of Education, 1971. 20p. ED 060 503.

Mushkin, S.J. and Cleveland, J.R. Planning for educational development in planning, programming, budgeting system. In Interdependence in school finance: The city, the state, the nation. Proceedings, 11th National Conference of School Finance. Dallas: NEA Committee on Educational Finance, 1968. As quoted in Lovell, N.B. Cost-effectiveness evaluation of instructional programs: A developmental design (K-12). (Doctoral dissertation, Florida State University, 1971).

Page, E.B. Seeking a measure of general educational advancement. The Bentee. Journal of Educational Measurement, Spring, 1972.

Pearson, R.H. A study of cost-effectiveness analysis with implications for instructional decision making. (Doctoral dissertation, Syracuse University, 1972). Dissertation Abstracts International, 1972, 33, 147A. (University Microfilms No. 72-20,363)

Quade, E.S. Analysis for public decisions. New York: American Elsevier, 1975.

Quade, E.S. Cost-effectiveness: An introduction and overview. Santa Monica, CA: RAND, May 1965b. (P-3134)

Quade, E.S. Cost-effectiveness: Some trends in analysis. Santa Monica, CA: RAND, March 1970. (P-3529-1)

Quade, E.S. A history of cost-effectiveness. Santa Monica, CA: RAND, April, 1971. (P-4557)

Quade, E.S. Introduction and overview. In T.A. Goldman (Ed.), Cost-effectiveness analysis. New York: Praeger, 1967b.

Quade, E.S. Methods and procedures. In E.S. Quade (Ed.), Analysis for military decisions. Chicago: Rand McNally, 1967a.

Quade, E.S. Some comments on cost-effectiveness. Santa Monica, CA: RAND, March 1965a. (P-3091)

Quade, E.S. and Boucher, W.I., (Eds.) Systems analysis and policy planning: Applications in defense. New York: American Elsevier, 1968.

Report to the President: White House Conference on Children, 1970. Washington DC: U.S. Government Printing Office, 1971. 439p. ED 052 828.*

The Resource Approach to the Analysis of Educational Project Cost. Washington, DC: Office of Education (DHEW), 1978 86p. ED 165 302. (Also available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 Stock No. 017-080-01914-1; $2.50.)

Rold, C.H. Issues in judging the cost-effectiveness of self-instructional programs: A case study in programmed dental instruction. Improving Human Performance, 3, (2), 1974, 49-63.

Rorro, C.M. A cost study analysis of school district implementation of T&E in New Jersey, 1978. (Unpublished doctoral dissertation at Fairleigh-Dickinson University).

Rossmiller, R.A. and Geske, T.G. Economic analysis of education: a conceptual framework. Theoretical Paper No. 68. Wisconsin Research and Development Center for Cognitive Learning, 1977. 78p. ED 148 024.

Rogers, D.D. Blunders commonly found in studies of the cost of instructional technology. Paper presented at the annual meeting of the Association for Educational Communications and Technology, Annaheim, CA., 1976.

Rogers, E.N. and Shoemaker, F.F. Communication of innovations. New York: Free Press, 1971.

Saettler, P. A history of instructional technology. New York: McGraw-Hill, 1968.

Scanlon, R.G. and Weinberger, J. Improving productivity of school systems through educational technology: Final report of symposium (Pub. No. RR-101). Philadelphia, PA: Research for Better Schools, 1973. 330p. ED 086 239.

Schramm, W. Big media little media: Tools and techniques for instruction. Beverly Hills, CA: SAGE, 1977.

Scriven, M.S. The methodology of evaluation. In R.E. Stake (Ed.), Curriculum evaluation. AERA Monograph Series on Evaluation. Chicago: Rand-McNally, 1967, (1).

Scriven, M. An introduction to meta-evaluation. Educational Product Report, 2, (5), 1969, 36-38.

Scriven, M.S. A checklist for the evaluation of products, producers, and proposals. In W.J. Popham (Ed.), Evaluation in education. Berkeley, CA: McCutchan, 1974.

Seibert, Ivan N. A handbook of standard terminology and a guide for recording and reporting information about educational technology. Washington, DC: National Center for Educational Statistics, 1975. 278p. ED 118 091.

Seiler, K. Introduction to systems cost-effectiveness. New York: Wiley-Interscience, 1969.

Smith, H.W. Strategies for social research. Englewood Cliffs, NJ: Prentice-Hall, 1975.

Spangenberg, R.W., Riback, Y. and Moon, H.L. The state of knowledge pertaining to selection of cost-effective training methods and media. Alexandria, VA: HumRRO, 1972. 138p. ED 078 295.

Stace, P. Program cost evaluation: An approach to evaluating direct and indirect net cost in the case of a program of study abroad. (Doctoral dissertation, Syracuse University, 1979). Dissertation Abstracts International.

Stakenas, R.G. and Kaufman, R. Costs and effectiveness of technological applications in education: A literature review. Tallahassee, FL: State of Florida, Department of Education, 1977. ED 169 922.

Swalm, R.O. Utility theory - insights into risk taking. Harvard Business Review. Nov-Dec, 1966, 123-136.

Temkin, S. A cost-effectiveness evaluation approach to improving resource allocations for school systems. Philadelphia, PA: Research for Better Schools, 1969. 220p. ED 041 380.

Temkin, S.A. A comprehensive theory of cost-effectiveness. Philadelphia, PA: Research for Better Schools, 1970. 66p. ED 040 503.

Temkin, S. Making sense of benefit-cost analysis and cost-effectiveness analysis. Improving Human Performance, 3 (2), 1974, 39-48.

Temkin, S. and McNamara, J.F. A comprehensive planning model for school districts: Decision rules and implementation strategies. Journal of Educational Administration, Oct 1973.

Temkin, S., Connolly, J., Marvin, M., Valdes, A. and Caviness, J. An economic assessment of Army training alternatives. Arlington, VA: Army Research Institute, 1975.

Tuscher, L.J. Cost utility analysis for program evaluation and resource allocation. Educational Planning, 1 (1), 1974, 46-58.

UNESCO. The economics of the new educational media. Paris: Author, 1977.

Vadhanapanich, S. Cost and effectiveness functions of instructional technology systems: A mathematical model. (Doctoral dissertation, Florida State University, 1976). Dissertation Abstracts International, 1976, 37, 3330-A. (University Microfilms No. 76-28,645)

Von Neumann, J. and Morgenstern, O. Theory of games and economic behavior (1st ed., 2nd ed.). Princeton, NJ: Princeton University Press, 1944, 1947.

Wagner, L. Television videotape systems for off-campus education: A cost-analysis of SURGE. Instructional Science, 4, (1975), 315-372.

Wilkinson, G.L. Cost evaluation of instructional strategies. Audiovisual Communication Review, 21 (1), 1973, 11-30.

Wilkinson, G.L. Economic evaluation in/of instructional development. In R.K. Bass and D.B. Lumsden (Eds.), Instructional development: The state of the art. Columbus, OH: Collegiate Publishing, 1978.

Witmer, D.R. Cost studies in higher education. Review of Educational Research, 42, 1972, 99-127.

AUTHOR INDEX

This index includes all authors named in citations in both the bibliography and references. Since a number of the works cited appear in both lists, two page references may refer to the same work. Such duplication is indicated by an asterisk after the second listing. More than one citation on the same page is indicated by a number in parentheses following the page number.

APPENDIX

Instructional Technology and Cost-Effectiveness Analysis

Characteristics of Instructional Technology

The Association for Educational Communications and Technology (1972, p. 36) has broadly defined instructional technology as the field devoted to the "facilitation of human learning through the systematic identification, development, organization and utilization of a full range of learning resources and through the management of these processes." Some specific applications of instructional technology include computer assisted instruction, programmed instruction, instructional television and instructional development.

Many advantages have been claimed for the use of instructional technology. Those studying its potential future impact on education have stressed its potential ability to improve the productivity as well as the quality of educational programs.

> With the demand for education outstripping education's income, more effective and efficient learning is vital. Instructional technology has shown its ability to speed up the rate of learning. It can help the teacher make better use of his time. It can reduce the teacher's routine job of information transmission. Thus the teacher would be able to spend more time on teaching... (Commission on Instructional Technology, 1970, pp. 30-31)

> Although short-run costs for the development and introduction of new instructional technology are expected to be very great, they will ultimately yield dividends. Much of the expanding technology has the potential economic effect of spreading the benefit of investment in a single unit of instruction among very large numbers of students. It therefore has the ability to increase the productivity of higher education. The earlier this increased productivity will be realized... (Carnegie Commission on Higher Education, 1972, pp. 45-46)

To test such claims for instructional technology, various writers have called for evaluations of its cost-effectiveness.

> We strongly recommend that broad-based studies be made of the costs and benefits that can be expected if the various technologies involving audiovisual equipment, television, computers, and other devices are applied to instruction in the schools on a wide scale. Such studies should take into account the benefits that may be obtained through increasing the effectiveness of the learning procers at the same time that they weigh the effects of the new resources in terms of the organization of instruction, teacher pay schedules, productivity, probable use by teachers, and other vital matters. (Committee for Economic Development, 1968, p. 19)

> We need to experiment with instructional management arrangements that permit mediated instruction to pay for itself. Cost-effectiveness information is a first step in buttressing arguments for such arrangements. Much more research, time, and effort are needed in this area. (Heinich, 1968, p. 222)

> If the full potential of technology in education is to be realized, well-prepared cost-benefit and cost-effectiveness analyses are necessary. (Grayson, 1972, p. 1216)

Cost-Effectiveness Defined

Determining the cost-effectiveness of something (such as an application of instructional technology) is a unique kind of evaluation activity. While definitions differ, cost-effectiveness can generally be defined as the relationship between something's inputs (costs) and outcomes (effectiveness) relative to the particular goal being served. Cost-effectiveness is a distinct characteristic or attribute of something that can be judged and compared against the similar attribute of another thing (Carpenter, 1970, p. 17). One alternative is judged as more cost-effective than another if, for example, it is more effective in reaching the goal for a given level of cost or if it reaches a fixed level of effectiveness for the lesser cost (Quade, 1975, p. 25).

Quade (1971, p. 2) groups cost-effectiveness analysis with cost-benefit analysis, policy analysis, operations research and other management sciences as sharing the common purpose of aiding decision making. Cost-effectiveness analysis is distinctive in that it is designed to compare

alternative approaches to a given goal. The cost of the alternative under consideration can generally be represented in monetary units. Effectiveness is usually not estimated in dollars, but rather is measured on a scale chosen to reflect the nature of the particular goal (i.e., achievement test scores). Thus, while cost-effectiveness analysis is a particularly flexible technique, it is only suitable for choosing among competing approaches to the same goal. When choices have to be made between competing goals as well as alternative activities, effectiveness must be measured in the same units as costs in order to make a meaningful comparison. Under these circumstances, the more specialized economic tool of cost-benefit analysis (comparing costs and benefits on identical scales of estimated monetary value) is more appropriate (Quade, 1971, pp. 2-3).

Cost-effectiveness analysis is, quite frankly, a technique for comparing programs, and may be used:

- -to help assess the relative worth of several innovative programs with the same educational outcome (such as improvement in reading achievement);
- -to determine whether a single program is becoming more or less effective as time passes so that steps may be taken to improve it, if necessary;
- -to help assess the relative worth of the same program for different student populations (such as those with differing socioeconomic backgrounds) or in different school settings.

The ability of cost-effectiveness analysis to assist in these kinds of decisions could impact upon the future use of instructional technology as an innovative or alternative approach to the problems facing education.

Development of Cost-Effectiveness Analysis in Education and Instructional Technology

Concepts and methods of cost-effectiveness analysis have been derived from economic theory, practical engineering and systems or operational

analysis (Quade, 1971, p. 8). Cost-effectiveness analysis has much in common with the older technique of cost-benefit analysis but, according to Quade (1971, p. 11), it evolved quite separately as a result of wartime work (1940's) in operational analysis. Within a few years, both techniques had been introduced to many analysts.

The methodology of systems analysis and, specifically, cost-effectiveness analysis developed slowly through the 1950's and early 1960's with applications to water resources projects (McKean, 1958) and military planning (Hitch & McKean, 1963). Support for analysis activities increased markedly when Charles Hitch became Assistant Secretary of Defense under Robert S. McNamara and a group of analysts and economists were brought to the Department of Defense. Within a few years analysis concepts began to spread throughout the federal government. In August 1965 President Johnson made the following announcement during a news conference:

> This morning I have just concluded a breakfast meeting with the Cabinet and with the heads of Federal agencies and I am asking each of them to immediately begin to introduce a very new and very revolutionary system of planning and programming and budgeting throughout the vast Federal Government, so that through the tools of modern management the full promise of a finer life can be brought to every American at the lowest possible cost.
>
> Under this new system each Cabinet and agency head will set up a very special staff of experts who, using the most modern methods of program analysis will define the goals of their department for the coming year. And once these goals are established this system will permit us to find the most effective and the least costly alternative to achieving American goals. (The New York Times, August 26, 1965, p. 14)

The application of cost-effectiveness analysis to education basically dates to President Johnson's directive and from that time on the adoption of the technique is readily apparent. For example, from 1956 to 1967 the Office of Education Research Reports listed four publications related

to analysis activities. In 1968, the new Educational Resources Information Center (ERIC) listed 22 references under the specific descriptor "cost-effectiveness" and by the 1970's the number of citations averaged 90-100 each year. The spread of cost-effectiveness analysis to the specific area of instructional technology followed a similar pattern. The first report of cost analysis of instructional media appeared in 1965 (Barson & Jones) and the term "cost-effectiveness" was first used in the professional journal Educational Technology a few years later (Caldwell, 1968).

As cost-effectiveness analyses began being conducted in education, however, a number of writers (e.g., Cogan, 1971; Grayson, 1972; James, 1969; Lovell, 1971) begin noting particular difficulties in adapting the methods of cost-effectiveness analysis to educational settings. Generally, these difficulties were seen to reflect the rather messy and ill-defined nature of educational decision situations as compared to the military and engineering contexts within which the technique was originally developed (Quade, 1975, p. 8). Mushkin and Cleveland (1968, p. 90) identified four factors which make analyses in educational settings particularly difficult:

(1) The long gestation period of educational outputs and the length of the necessarily sequential learning processes.

(2) Our limited knowledge of the learning process which might hamper attempts to attribute a particular result to the actual activity which produced it.

(3) The multiplicity of objectives in education which complicates the task of assigning a particular activity to the final educational purpose which it serves.

(4) The difficulty of factoring out the effects of non-school experiences on the process and product of learning.

In a detailed critique, Levin (1971) outlined the problems facing the cost-effectiveness analysis of instructional technology and concluded that "most of the requirements for sound cost-effectiveness analysis cannot be satisfied given our present knowledge of the educational process" (p. 1000). This conclusion was arrived at through his interpretation of education as a production process where educational goals define the outputs of the process; students, teachers, and other resources define the inputs to the process; and the various instructional strategies and other techniques for combining these inputs define the means of producing the various outcomes. He argued that although current knowledge and theory in any of these areas is too limited to support the conduct of cost-effectiveness studies, the effort must continue provided that we "recognize the formidable height of the barriers placed in the path of cost-effectiveness analyses in education rather than pretending that our hurdling ability is sufficient over any course" (p. 1004).

Cost-effectiveness analysis has now been part of the lexicons of education and instructional technology for over ten years. During this period there have been marked advances in the theory and methodology of the closely related fields of educational evaluation and cost analysis (e.g., Belmore, 1972; Coombs & Hallak, 1972a; Glass, 1969; Haller, 1974; Scriven, 1967; Stufflebeam, 1971; Witmer, 1972). In addition, a considerable literature has grown up around the methodology of educational cost-effectiveness analysis with some particularly notable contributions by Alkin (1969), Doughty and Stakenas (1973), Levin (1975), and Temkin (1969). Unfortunately, all this activity seems to have had a limited effect upon the actual conduct of cost-effectiveness studies in education and specifically instructional technology, at least as such studies are

reflected in the literature.

Previous Reviews

There have been four recent attempts to summarize or critique available studies on the cost-effectiveness of instructional technology. The most comprehensive survey was conducted by Caffarella (1973, 1975a, 1975b), who identified over 400 references in this general area. After reviewing approximately 300 of these references, Caffarella found only 32 that reported either empirical studies or included findings supported by quantitative data. Much of the literature consisted of expositions regarding the requirement and methodology for cost-effectiveness studies. He concluded that, "The current quantity and quality of research on the cost-effectiveness of instructional technology is low... it is evident that even though there has been a proliferation of writings in the cost-effectiveness of instructional technology there has been very little research on the subject" (1975a, p. 15). Carnoy (1976) and Carnoy and Levin (1975) have conducted more detailed examinations of a smaller, selected group of cost-effectiveness studies. In his 1976 article, Carnoy examined both the analytical and empirical bases upon which instructional television is being justified as a solution to the problem of providing "quality" education to people in developing countries. While this study did not focus strictly on cost-effectiveness investigations, Carnoy did describe a number of flaws in past applications of the technique in television studies and suggested better ways to conduct such studies in the future.

The Carnoy and Levin (1975) article reviewed six investigations on the costs and effectiveness of educational media (radio, television,

computer assisted instruction, and video-taped instructional systems). Their review mainly explored the impact of two kinds of bias ("benefit of the doubt" and "ignoring other effects") on the conduct and conclusions of these six studies. Finally, Rogers (1976) reported on problems he found in three studies on the cost and/or cost-effectiveness of instructional technology. This analysis focused exclusively on methodological problems in the costing of instructional technology.

These reviews seem to suggest two things about the state of cost-effectiveness analysis of instructional technology. First, it appears that relatively few studies have actually been conducted (assuming that most formal studies have found some publication outlet). In fact, this situation may be even more severe than Caffarella's findings suggest. A careful review and updating of his 1973 study suggests that Caffarella used the most liberal interpretation of what constituted a cost-effectiveness study. If only those studies are considered which are specifically recognizable as attempts to investigate cost-effectiveness, then the total number of empirical investigations of instructional technology reported to date is approximately 15 (depending on definitions of "empirical" and "instructional technology"). The second conclusion that can be drawn about the reported studies is that they are characterized by a variety of shortcomings. For example, both Caffarella (1975b) and Carnoy (1976) have pointed out the general failure of most studies to deal with the whole effectiveness side of the comparison.

One possible explanation for the poor state of the empirical literature is suggested by the nature of the methodological discussions intended to explain and support the conduct of such studies. From even a cursory review of this literature, it becomes apparent that there is

confusion and disagreement over some of the most fundamental concepts of educational cost-effectiveness analysis. For example, there are conflicting recommendations as to the basic structure of the analysis. Some authors (e.g., Carpenter & Haggart, 1972) argue that, in educational settings, analyses should be conducted on a fixed cost basis which compares the effectiveness of alternatives at a given level of resource use. Taking another point of view, other analysts favor fixed effectiveness comparisons which analyze costs at a set level of effectiveness (e.g., Grayson, 1972). Still other analysts advocate the use of both fixed cost and fixed effectiveness comparisons (e.g., Kazanowski, 1968a), or they argue for the use of a variable approach that fixes neither side of the comparison.

Some of this confusion and disagreement is less striking, perhaps, when one realizes that there is no standard definition for what constitutes a "cost-effectiveness analysis." The definitions employed by different analysts often vary in subtle but important ways. For example, in the quotations given below the definition used by the National Center for Educational Statistics emphasizes resource analysis while the definition offered by Diamond et al. stresses the determination of effectiveness, and Meeth's definition stresses the interaction between both sides of the analysis.

> Cost-effectiveness - Analyses designed to measure the extent to which resources allocated to a specific objective under each of several alternatives actually contribute to accomplishing that objective, so that different ways of gaining the objective may be compared. (National Center for Educational Statistics, 1975, p. 214)

> Cost-effectiveness analysis is a process which attempts to determine the most effective and efficient way of reaching the goals that have been identified. The key problem, therefore, is to identify and measure those elements which together describe the effectiveness and efficiency that is required. (Diamond, Eickmann, Kelly, Holloway, Vickery, and Pascarella, 1975, p. 113)

> It is the act of comparing the relationship between input and output between the resources and their related dollar costs and the achievement of desired goals, competencies, or other outcomes... Cost-effectiveness analysis is a qualitative judgment made about the relationship of cost to outcomes. (Meeth, 1975, p. 124)

With this kind of variation in the methodological literature it seems hardly surprising that the cost-effectiveness analysis of instructional technology has proceeded at a relatively slow pace in terms of the conduct of actual studies and the further development of new methods. This, however, is not the first time that the confused state of the methods for analysis has been noted and cited as an important problem that needs to be resolved. In what is becoming a classic article in the field, Kazanowski (1968a) argues the necessity of a standardized approach to cost-effectiveness evaluations.

> The lack of uniformity that is apparent, in almost any sample of cost-effectiveness evaluations has resulted in a questioning of the merits of cost-effectiveness as an aid to decision-making. Although it is recognized that numerous approaches to cost-effectiveness evaluations may generate equally valid results, the plethora of different approaches, when combined with questionable evaluations, unavoidably generates a skepticism of the merits of cost-effectiveness analysis in the minds of the recipients of the evaluations. Thus what could be a valuable decision aid becomes a questionable technique viewed with considerable skepticism. (p. 113)

Shortly thereafter, Temkin (1970) reached similar conclusions specifically in regard to cost-effectiveness studies in education:

> In the past few years countless authors have suggested, in one way or another, that cost-effectiveness methods be used as a basis for decision-making in education. As one sorts and analyzes these proposals and prescriptions two important inadequacies become evident:
>
> (1) Firm theoretical bases for these studies are lacking. Theory, in the domain of decision-making, should provide not only a basis for description and explanation but explicit statements of assumptions underlying the proposed rationale and methodology.

> (2) Little help is offered to the individual who wishes to select from the various economic based approaches an appropriate method to apply to a practical problem. (p. 1)

In spite of the efforts of both of these authors to remedy the situation, it continues today. In 1976 Vadhanapanich reviewed the state of the methods for analyzing instructional technology's cost-effectiveness and concluded that, "The procedure of cost-effectiveness is not well understood; because of the lack of methodological and conceptual guidelines for analysis of instructional technology, the cost-effectiveness approach has not yet been widely implemented" (p. 2).

Thus, after more than ten years of activity directed towards the cost-effectiveness analysis of instructional technology, useful studies in the area are relatively few in number and uncertain in quality. The concepts and procedures involved in conducting the studies remain uncertain in many instances. In short, it is not clear what progress has been made in adapting the methods of cost-effectiveness analysis to the particular circumstances surrounding evaluations of instructional technology. Further work is required in developing, clarifying, and standardizing the practice of cost-effectiveness analysis if it is to be truly useful and more widely employed in decision-making.

As other analysts have noted these problems they have mounted their own efforts to resolve them. Kazanowski (1968a), Temkin (1970), and Seiler (1969) have all made considerable contributions to the general methodology of cost-effectiveness analysis. Studies by Pearson (1972) and Vadhanapanich (1976) have aimed at unifying and clarifying methods specifically devoted to the analysis of instructional technology. In spite of the work of these and other analysts, however, the problems

persist. Further work and new approaches to methodological study are needed in this area.

Methodological studies of cost-effectiveness analysis have typically begun with the development of a hypothetical model for analysis based on various bodies of existing theory. This model is then variously subjected to demonstration, review or validation under real or contrived circumstances. The usual intent is to document the worth and generalizability of the proposed model. In a few instances (e.g., Doughty, 1973) another approach has been used which begins with a particular problem for analysis, develops or adapts methods and techniques for analyzing that problem, reports the analysis, and concludes by discussing the worth of the study's process and findings. So far neither approach has produced generalizable procedures or results that are robust enough to survive the reality of cost-effectiveness analysis in educational settings.

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